Soil electrical resistivity, a new and revealing technique for precision viticulture

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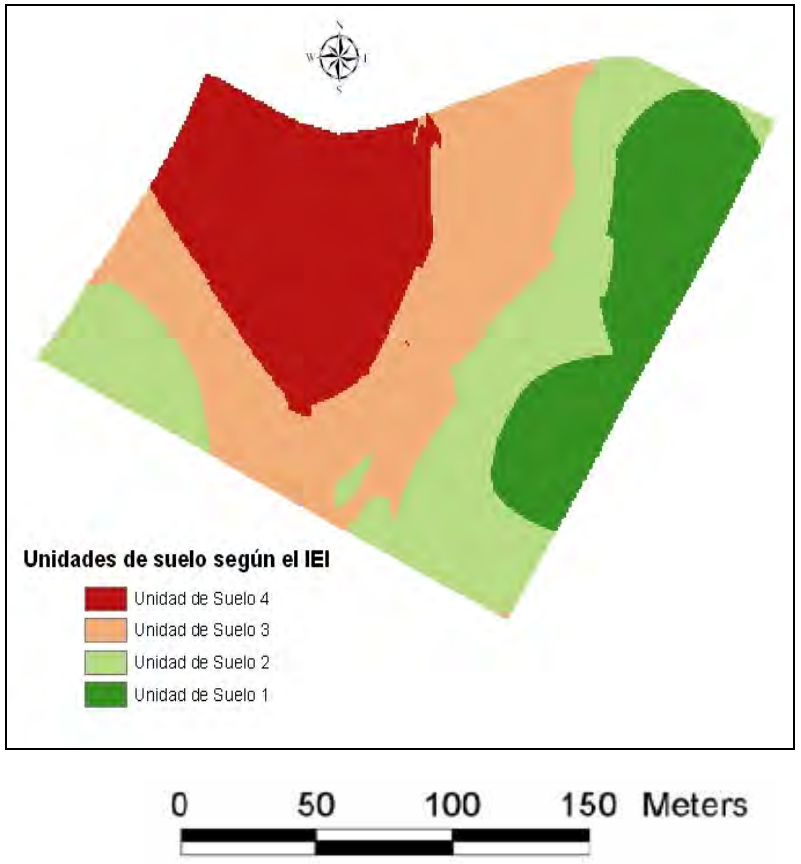
Spatial variability of the vineyard

Proximal and remote sensors in viticulture

Traditional soil sampling

Vineyard mapping using a soil profiles



Tardaguila et al. 2011 Prec. Agric

Sensors for mobile mapping in agriculture

Gebbers

Mechanical
- Fuel consumption: 0
- Draft force: 0
- Vertical penetrometer: ?
- Horizontal penetrometer: 0

Chemical
- Galvanic: ?
- Ion-selective electrodes (pH): +
- Field effect transistors: 0
- Artificial nose: −
- Antibodies: −

Optical
- Vis-NIR spectroscopy: ? 0
- Imaging: ? 0
- Raman spectroscopy: −
- Plasma spectroscopy: −

Electrical
- Geo-electrical: +
- TDR: 0
- Geo-radar: 0
- THz: −

Radioactivity
- Gamma spectrometry (pass.): +
- Impulse-neutron (active): −
- XRF: 0

Acoustical („seismics“)
- Response to sound: −

Pneumatic
- Movement of air in soil: −

+ Commercially available / accepted

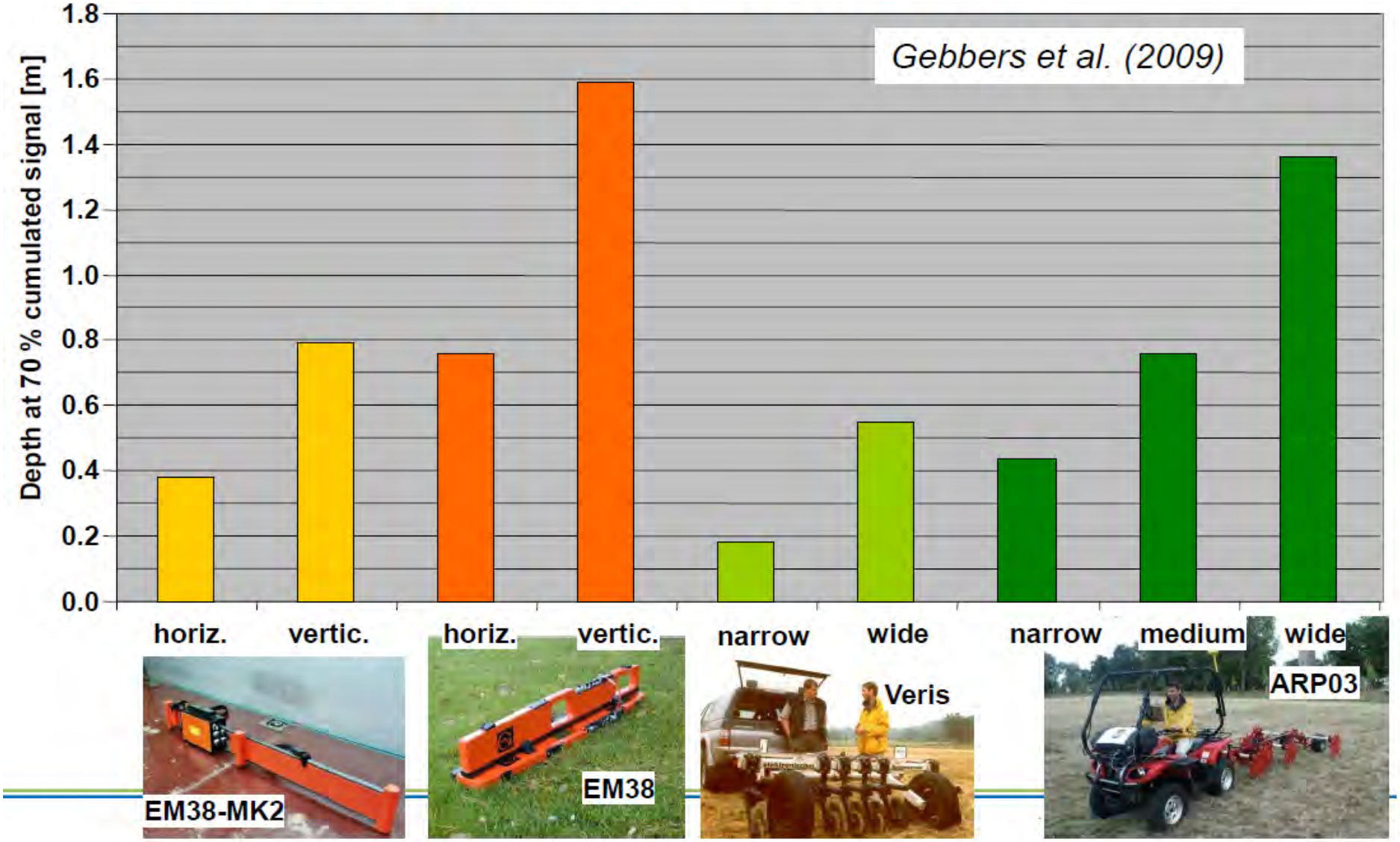
? Commercially available, not accepted / adopted

0 Under development / promising

− Research only

Gebbers. 2014

Geo-electrical sensors: Depth of investigation



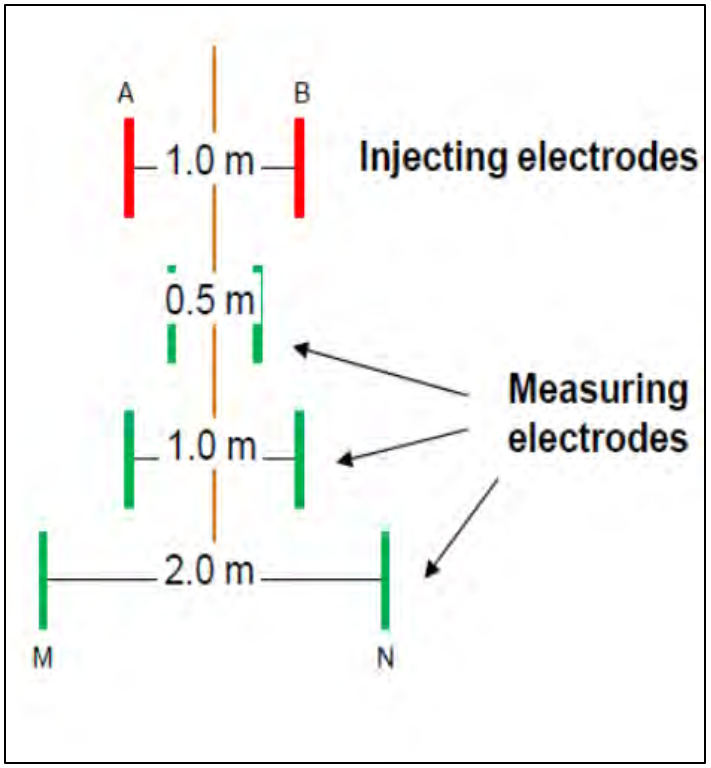
Goal

Using an ARP sensor on-the-go to map homogeneous soil zones that might correspond to differentiated areas of growth and yield of an established vineyard

Material and methods

Tempranillo vineyard, Navarra, Northern Spain

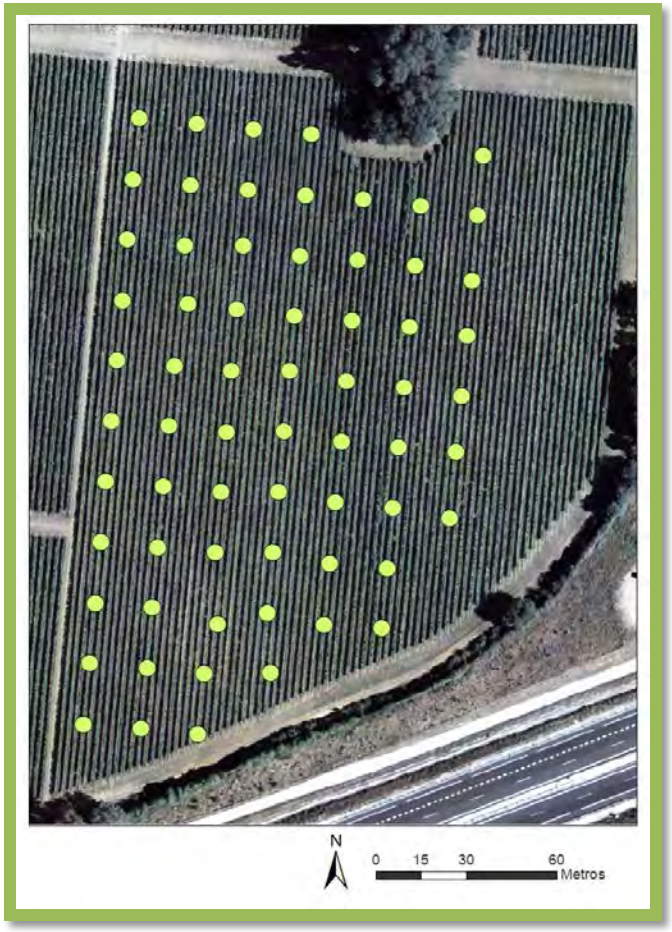
On-the-go measurement of soil electrical resistivity



Automatic Resistivity Profiling (ARP) sensor

On-the-go measurement of soil electrical resistivity in a Tempranillo vineyard using a ARP sensor

Soil and plant sampling



Speed: 10 km/h

30,000 measurements/ha

3.6 ha Commercial Tempranillo VSP vineyard. Navarra. Spain

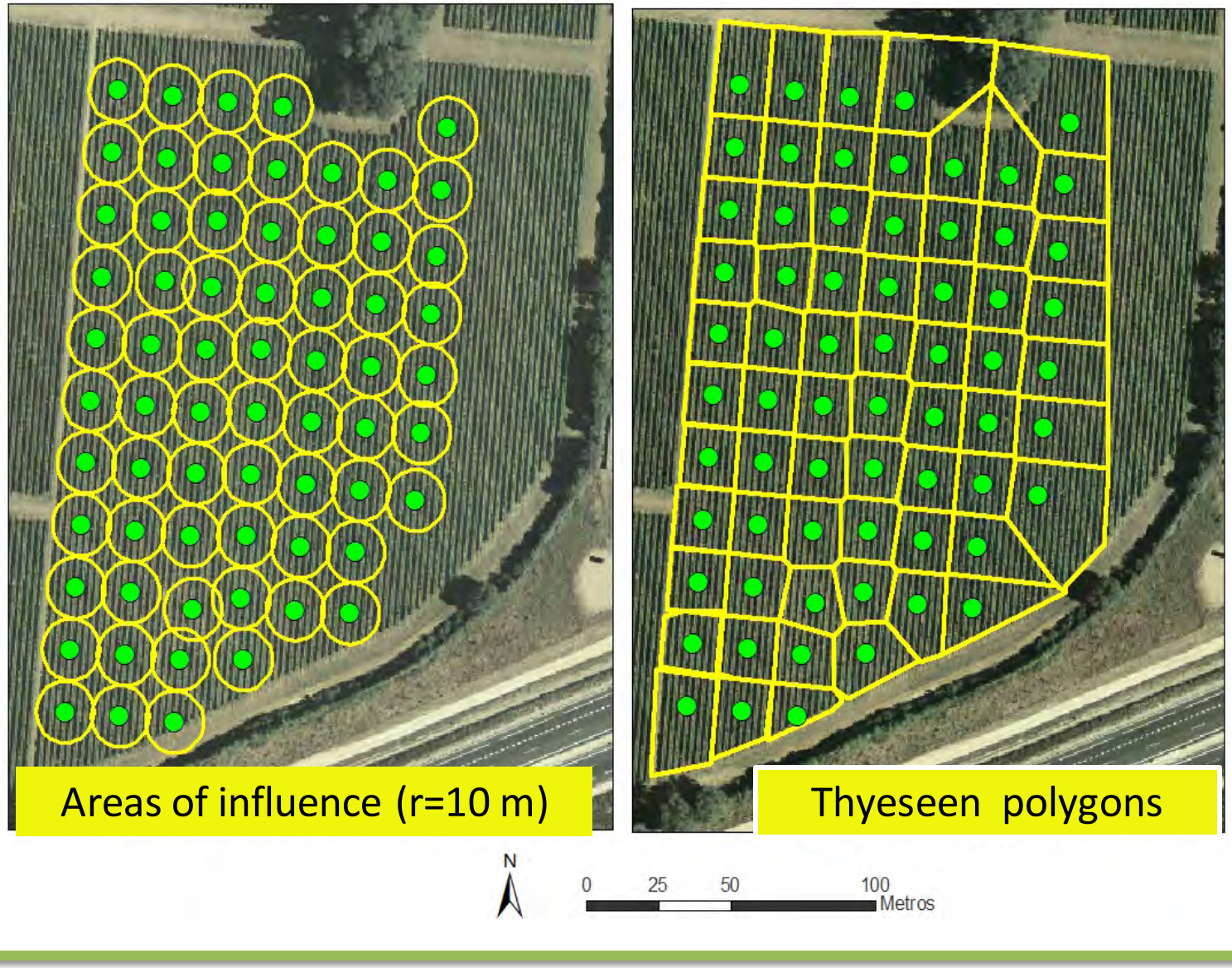
Yield and growth sampling

Yield components
- #Clusters/vine
- Cluster weight
- Crop yield/vine

Vegetative growth
- Chlorophyll index
- Total shoot length
- Pruning weight

66 sampling points
- 3 vines/point

Association between soil and vine data

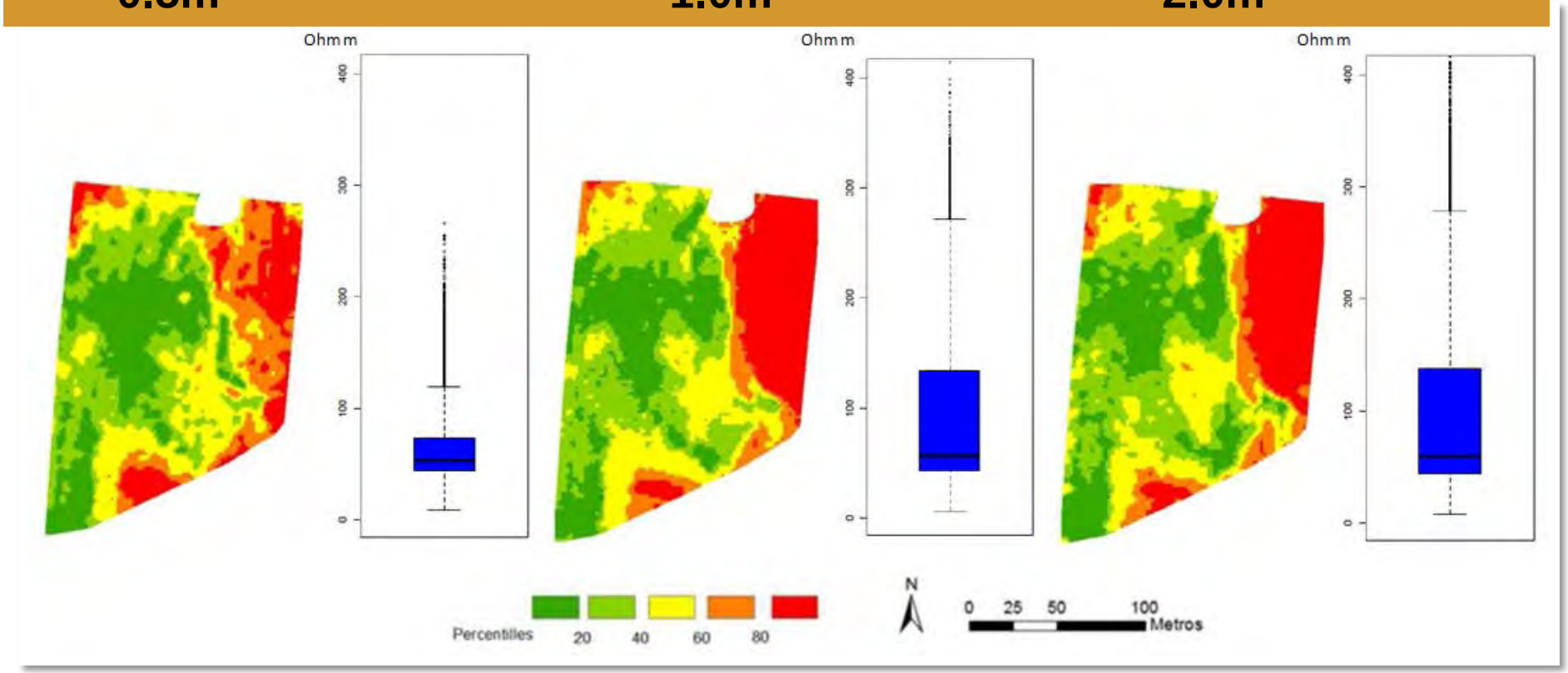


Results

Mapping soil electrical resistivity at different depths

Depth:

0.5m **1.0m** **2.0m**

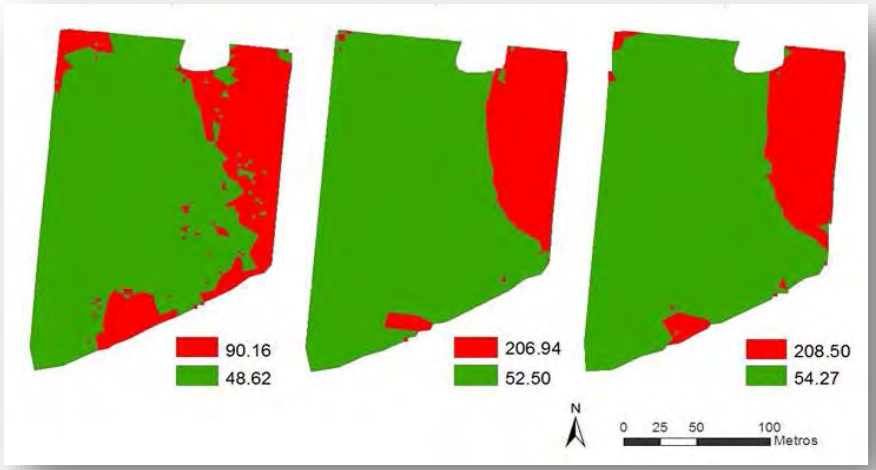


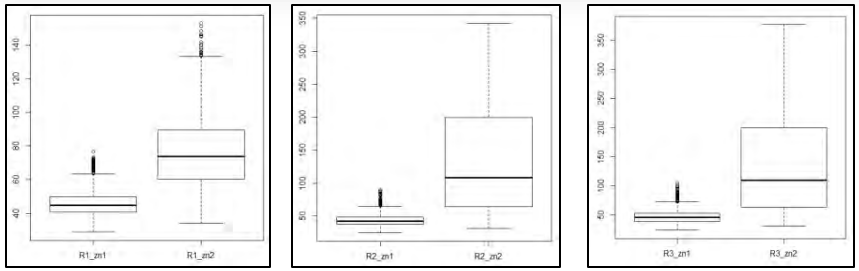
Correlation (R^2) between ER at different depths

	ER at 0.5 m	ER at 1.0 m	ER at 2.0 m
ER at 0.5 m	1.00	0.68	0.65
ER at 1.0 m	0.68	1.00	0.95
ER at 2.0 m	0.65	0.95	1.00

Number of soil zones in the vineyard

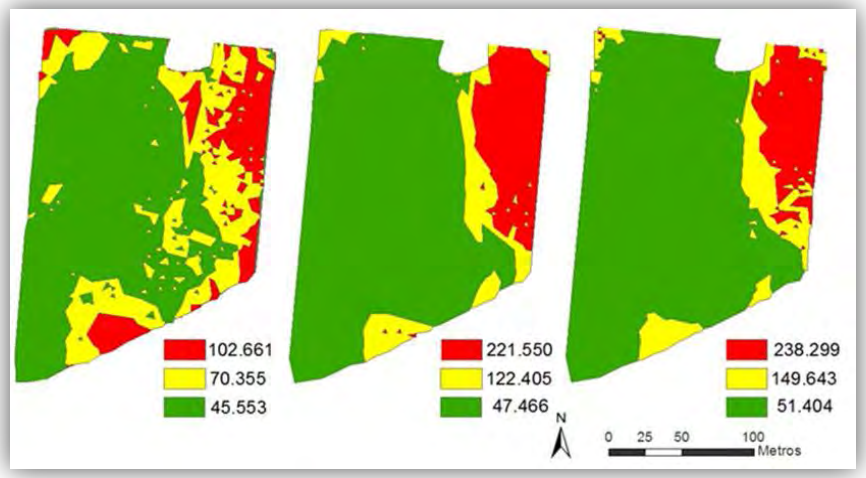
2 zones

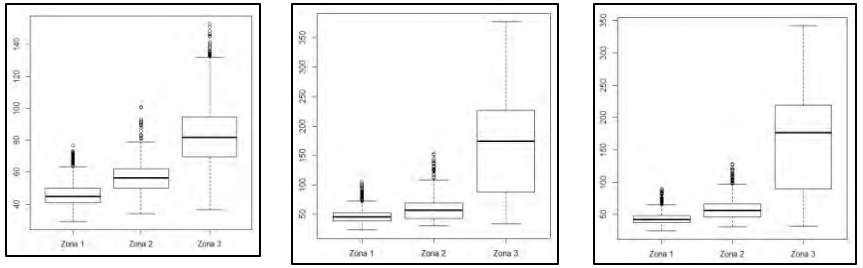




Depth: 0.5m 1.0m 2.0m

3 zones

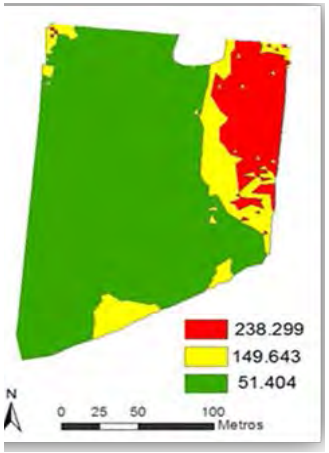




Depth: 0.5m 1.0m 2.0m

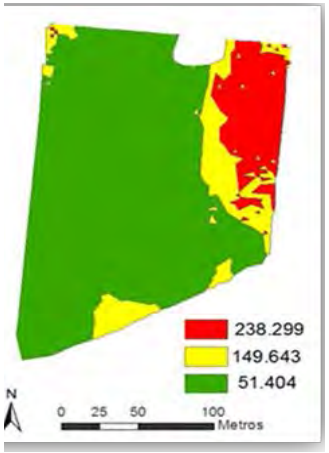
Correlation betweenn soil electrical resistivity and viticultural parameters

	Cluster number/ vine	Yield (kg/vine)	Cluster weight (g)	Shoot lenght (m)	Pruning weight (g/vine)
ER at 0.5 m	-0,435*	-0,524*	-0,435*	-0,550*	-0,390*
ER at 1.0 m	-0,509*	-0,598*	-0,509*	-0,632*	-0,451*
ER at 2.0 m	**-0,568***	**-0,643***	**-0,568***	**-0,700***	**-0,490***



Soil electrical resistivity and viticultural parameters

	Cluster number/ vine	Yield (kg/vine)	Cluster weight (g)	Shoot lenght (m)	Pruning weight (g/vine)
Zone 1	17.22 a	3.12 a	176 a	1.39 a	695 a
Zone 2	12.75 b	1.71 b	123 b	1.06 b	533 b
Zone 3	6.51 c	0.55 c	62 c	0.81 c	391 c



Conclusions

- ARP sensor for measuring the soil electric resistivity on-the-go proved fast, reliable and useful tool in precision viticulture.

- ER showed highly significant spatial distribution that permitted to define soil homogeneous areas that were related to significant differences in growth and yield of grapevines.

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